PENNSTATE

PROPOSAL TRANSMITTAL

Date: 12/23/2014 **OSP No:** 178600

Title: Center for Multi-Scale Nutrient Pollution Solutions (Supplement)

Submitted to: Dale Manty via email
U.S. Environmental Protection Agency
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Current Agreement 83556801
OSP # 164197

Program: Research Project

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John W. Hanold Date: 12/23/14
John W. Hanold, Interim Director
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Please reference OSP Number in all correspondence.

Center for Integrated Multi-Scale Nutrient Pollution Solutions
Project 1 - Nutrient Pollution: Drivers & Interventions

Supplement: Extension of Atmospheric Nitrogen Deposition Models for the Chesapeake Bay Watershed and Tidal Waters

Statement of Work

Elizabeth W. Boyer and Jeffrey W. Grimm

Objectives

Nitrogen pollution of surface waters is associated with many large-scale environmental concerns, including eutrophication, harmful algae blooms, hypoxia, acid rain, nitrogen saturation in forests, and global warming, and more. Nitrogen discharges into the surface waters throughout the Mid-Atlantic region and the Susquehanna/Chesapeake Basin derive from many different sources, land-uses, and locations across the watersheds. Project 1 aims to guide the Center for Integrated Nutrient Pollution Solutions (CNS) with a regional-scale, systematic account of the sources and sinks of nutrients that impact watersheds and water quality. This approach provides a scientific perspective from which to understand drivers of the nutrient pollution problems and to explore potential intervention strategies to mitigate nutrient pollution problems.

In this supplemental request to CNS Project 1, we aim to add further to our work on **atmospheric nitrogen deposition** as a driver of nitrogen pollution in the Chesapeake Bay region. We had originally budgeted to use publicly available information on atmospheric nitrogen deposition available from the National Atmospheric Deposition Program, but advancing the spatial and temporal resolution of this information is important Project 1, and is desirable to the US Environmental Protection Agency's Chesapeake Bay Program. **The primary goal of this supplement to the project is to estimate rates of atmospheric deposition of ammonium and nitrate to the Chesapeake Bay Watershed and adjoining tidal waters, from 1983 to 2013, using modeling approach.** The supplemental budget here allows for Jeffrey Grimm, who has previous experience with high resolution atmospheric deposition modelling, to join the project and lead the proposed modelling work.

Methods

Weekly and daily precipitation chemistry observations from NADP/NTN and AirMON network monitoring stations located within the modeling domain and which were are active during 1983 through 2013 will be acquired and quality-controlled for compliance with sampling protocols. From the quality-controlled observation set, a subset of observations representing single precipitation events will be identified and used for subsequent model development.

Output from the NLDAS-2 weather reanalysis model has been designated by the Chesapeake Bay Program as the standardized source for surface weather data for modeling projects. As such,

applicable hourly surface weather parameters from NLDAS-2 will be incorporated into this modeling effort. Total and convective precipitation, 2m temperatures, and surface pressure from NLDAS-2 will be used in this model extension project and downward short wave radiation from NDLAS-2 will also be evaluated for use in modeling NOx conversion rates and release rates of ammonia emissions from surface sources (i.e., fertilized fields). The fraction of precipitation occurring from convective events will also be evaluated for use in improving concentration and deposition estimates. NLDAS-2 hourly grids have a native resolution of 1/8th degree and will be downscaled to 1/24th degree resolution by bilinear interpolation for use in our modeling effort.

Additional upper-air parameters will be required to model the atmospheric transport of emissions and to calculate trajectories of precipitation events. Upper-air data is not available from the NLDAS-2 model and will be obtained from the North American Regional Reanalysis model (NARR) instead. The NARR data has an approximate spatial resolution of 1/4 degree and is available in 3-hour time steps. NARR grids will be downscaled to 1/24th degree resolution by bilinear interpolation and hourly values will be derived by linear interpolation between 3-hour NARR model time steps. Minimally, u- and v-wind velocities, vertical velocities, boundary layer heights, and precipitable water values will be incorporated from the NARR into our modeling effort and additional parameters may be considered. Pressure-level parameters (e.g., wind and vertical velocities) will be extracted at 1000, 950, 900, 850, 800, 700, and 600mb heights.

Land cover and land use data will primarily be derived from National Land Cover Databases (NLCD). The availability of multiple NLCD issues during the latter portion of the modeling period is expected to improve the accuracy of the land use parameters used in our model development. 30m resolution NLCD grids will be reclassified into croplands, potential livestock production areas, residential areas, industrial and commercial sites, and transportation corridors. The proportional composition of the major land use categories within and surrounding each 1/24th-degree model domain grid cell and monitoring site location will be calculated and used in modeling the spatial distribution and output of emissions sources, ionic wet-fall concentrations, and wet deposition rates.

County- and point-level estimates of ammonia and nitrous oxide compound (NOx) emissions will be primarily taken from the EPA National Emissions Inventory (NEI) summary series from 1990 through 2011. Estimates of emissions levels for years prior to 1990 will be adjusted based on the national NEI Air Pollutant Emissions Trends Data for Tier 1 CAPS. County-level nonpoint emissions estimates from NEI databases will be spatially apportioned to model grid cells based of the relative composition of land cover and land use derived from the NLCD data sets. EPA fertilizer application data will also be used to define the location and intensity of ammonia emissions. As with the county-level NEI emissions estimates, the spatial distribution of fertilizer applications among model grid cells will be calculated based NLCD land use composition estimates. The timing and relative level of emissions release rates from fertilizer applications will be determined using NASS crop phenology data, soil temperatures, and, possibly, downward shortwave radiation fluxes. Additional sources of ammonia and NOx emissions, such as Mobile-4 and CMAQ emissions inventories for point and non-point sources, will be sought and evaluated for use in this model extension project.

The emissions transport model will be run for the entire model domain grid for the duration of the 1983 through 2013 modeling period in a continuous series of 1-hour time-steps to estimate ambient atmospheric concentrations of NOx compounds and ammonia. Emissions release rates from croplands will adjusted seasonally as described in the preceding section. NOx emission rates from facility power production sources will be seasonally adjusted according to variations in heating and cooling demands. Emissions rates for on-road transportation sources will also be adjusted to reflect seasonal changes in vehicular traffic volumes. Precipitation event back-trajectories of 6-, 12, and 24-hour durations will then be calculated in 1-hour time-steps for each precipitating air parcel to estimate exposure of the air mass to transported emissions.

Linear multiple regression analyses will be performed using the single-event precipitation ammonium and nitrate concentrations obtained from NADP/NTN and AirMON monitoring sites as dependent variables against a set of predictor variables representing long-term trends, seasonality, surrounding land use composition, precipitation event volume, antecedent precipitation volume, latitudinal and longitudinal gradients, emission source proximity, and event back-trajectory exposure to transported emissions. The best fitting model will identified for ammonium and nitrate concentrations in precipitation and used to estimate daily wet-fall concentrations and wet depositions for each cell in the modeling domain grid for the duration of the modeling period.

Daily estimates of ammonium and nitrate wet deposition will subsequently be accumulated into annual totals and verified against annual deposition records from NADP/NTN and AirMon sites. Only deposition records from monitoring sites meeting annual reporting completeness levels of at least 75 percent will be used for model output verification. Time series plots showing both reported and estimated annual wet deposition values at monitoring sites with long spans of complete monitoring report activity (e.g., PA42) will also be generated and used to evaluate the model output.

Annual and daily ammonium and nitrate wet deposition fluxes to CBW sub-basins and to land and tidal water segment polygons will be generated by aggregating corresponding deposition estimates from the 1/24th-degree model grid and delivered to the Chesapeake Bay Program Office.

Deliverables

The anticipated timeline for the project is 1 year. Annual and daily ammonium and nitrate wet deposition fluxes to CBW sub-basins and to land and tidal water segment polygons will be generated by aggregating corresponding deposition estimates from the 1/24th-degree model grid and delivered to the Chesapeake Bay Program Office. A final report detailing the model development will be prepared and submitted to the Chesapeake Bay Program Office. Subsequent publication of the model development and application will be pursued and will include acknowledgement to EPA for funding and credit for technical and data contributions to the modeling project.

Budget Justification

Salaries and Wages: $20,525. The principal investigator of Project 1, Elizabeth W. Boyer is budgeted for 1.5 weeks of summer salary shown using her actual salary in the calculation. Jeffrey W. Grimm, who will lead the modelling effort, is budgeted for approximately 25% of his time monthly for one year.

The principal investigator is budgeted at the percentage of time shown using his/her actual salary in the calculation. The principal investigator's time includes both technical and project management functions. Any other individuals/positions shown are technical staff with the percentage of time shown and actual salaries used. For project time occurring after July 1 of any given year, the salaries have been adjusted at the University approved rate of 2.5%.

Fringe Benefits: $7,388. Fringe benefits are computed using the rates of 36.0% applicable to Category I Salaries (Boyer and Grimm).

Fringe benefits are computed using the fixed rates of 36.0% applicable to Category I Salaries, 13.1% applicable to Category II Graduate Assistants, 7.8% applicable to Category III Salaries and Wages, 0.1% applicable to Category IV Student Wages, and 25.0% for Category V, Postdoctoral Scholars and Fellows, for fiscal year 2015 (July 1, 2014, through June 30, 2015). If this proposal is funded, the rates quoted above shall, at the time of funding, be subject to adjustment for any period subsequent to June 30, 2015, if superseding Government approved rates have been established. Fringe benefit rates are negotiated and approved by the Office of Naval Research, Penn State's cognizant federal agency.

Materials and Supplies: $5,532. The proposed work involves heavy computing and data assimilation, and the funds requested for supply items include computer hardware and software that will be dedicated to the project.

Indirect Charges: $16,555.
F&A – On Campus Research - F&A rates are negotiated and approved by the Office of Naval Research, Penn State's cognizant federal agency. Penn State's current provisional on-campus rate for research is 50.7% of MTDC from July 1, 2014, until amended. New awards and new competitive segments with an effective date of July 1, 2015, or later shall be subject to adjustment when superseding Government approved rates are established. Per 2 CFR 200 (Appendix III, Section C.7), the actual F&A rates used will be fixed at the time of the initial award for the duration of the competitive segment. F&A rates for this proposal is calculated at 49.5% for based on the original award date of the current agreement # 83556801 (OSP#164197).

Total requested from Sponsor: $50,000

Agricultural Economics, Sociology and Education (Agricultural Sciences) / The Pennsylvania State University
Center for Multi-Scale Nutrient Pollution Solutions (Supplement)
Environmental Protection Agency
Project Dates: 02/01/2015 - 01/31/2016

	02/01/2015 - 01/31/2016	Total
Direct Costs		
Salaries (Category I)		
Shortle, James Samuel (Principal Investigator)	0	0
Boyer, Elizabeth Weeks (Co-PI)	4,355	4,355
~ 3% Effort		
Grimm, Jeffrey Wayne (Co-PI)	16,170	16,170
~ 25% Effort		
Total Salaries	20,525	20,525
Total Salaries and Wages	20,525	20,525
Fringe		
Category I @ 36.00%	7,388	7,388
Total Fringe	7,388	7,388
Total Salaries, Wages and Fringe	27,913	27,913
Modified Total Direct Costs		
Materials & Supplies	5,532	5,532
Computer Hardware & Software		
Total Modified Total Direct Costs	33,445	33,445
Total Direct Costs	33,445	33,445
F&A Costs		
F&A Rate: 49.50%	16,555	16,555
Total Requested From Sponsor	50,000	50,000
Total Project Costs	50,000	50,000

Proposal: 25476
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